VIRGINIA RESPONSIBLE LAND DISTURBER CERTIFICATE OF COMPETENCE PROGRAM

APPLICANT PACKET

Virginia Department of Conservation and Recreation
Division of Soil and Water Conservation
Urban Programs

How To Use The Applicant Packet:

1. **All of the information required to correctly answer the RLD Certification examination/test questions is contained within this packet.**

2. **The applicant should become familiar with this information.**

3. **The applicant is not expected to read or memorize all of this information. The exam is timed (1hour) and open book.**

4. **The applicant should bind, tab, and highlight the 3 sections of the packet separately so correct information can be rapidly and easily located. The exam questions and packet are organized into these 3 separate sections: Law and Regulations, Principles and Practices, and ESC Specifications.**

5. **The applicant should become very familiar with the table of contents and the ESC Specifications index so that correct information can be quickly located.**

About the RLD Certification Exam/Test:

1. **The exam will consist of 25 multiple-choice questions.**

2. **The exam is open book and timed (1 hour long).**

3. **The exam will be administered over the internet through any computer (with printer) that has access to the DCR exam website.**

4. **All of the information necessary to correctly answer the questions can be found in the Applicant Packet. The packet is available free of charge from the DCR website.**

5. **The exam and the packet are organized into 3 sections:**

Law and Regulations will have:	**5 questions**
Principles and Practices will have:	**5 questions**
ESC Specifications will have:	**15 questions**
Total Exam Questions:	**25 questions**

6. **If the applicant answers 17 or more of the exam questions correctly he or she will receive their printed RLD Certificate and DCR website listing instantly.**

7. **If the applicant answers 13 or more of the exam questions correctly but less than 17 questions correctly then a free retest will be available. The free retest will be 10 questions and 25 minutes long. The free retest will cover only those sections of the exam that the applicant answered less than 80% correct. Further directions on the free retest will be provided to those that qualify.**

8. **If the applicant answers 12 or less questions correctly then he or she will be required to take the entire exam again at the full fee to obtain certification.**

9. **No two exams are the same. All exams are composed of randomly sorted questions from a database of over 1200 questions.**

10. **The RLD certification application fee is $90 and the certification will be valid for 3 years beyond the date of issuance.**

11. **Major credit cards will be accepted via the website. No cash or checks will be accepted by DCR.**

12. **The certification exam is anticipated to be available 24 hours a day/seven days a week from any computer (with printer) that has internet access to the DCR website at www.dcr.state.va.us/sw/e&s.htm on or before June 27, 2001.**

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INTRODUCTION

The Virginia Erosion & Sediment Control Law (Title 10.1, Chapter 5, Article 4 of the Code of Virginia) (Law) delineates the rights and responsibilities of the governments that administer the Commonwealth of Virginia's Erosion and Sediment Control (ESC) Program and the property owners who must comply. The ESC Program is intended to control soil erosion, sediment deposition, and nonagricultural runoff from regulated "land-disturbing activities" to prevent degradation of property and natural resources. A network of locally operated ESC Programs regulates most private projects that involve a land-disturbing activity, while state agency projects are overseen by the Virginia Department of Conservation and Recreation (DCR).

The "Responsible Land Disturber (RLD) Certificate of Competence Program" was established as a component of the ESC Program by revisions to the Law that became effective on July 1, 2001. Beginning in July 2001, as a prerequisite for erosion and sediment control (ESC) plan approval, the person responsible for carrying out the plan must provide the name of an individual holding an RLD Certificate who will be in charge of and responsible for carrying out the regulated land-disturbing activity. To meet this mandate, DCR operates the RLD Certificate of Competence Program.

The principal objectives of the RLD Certificate of Competence Program are:

1. To present a wide array of educational material that promotes a baseline understanding of the Law, Regulations and Minimum Standards, basic ESC principles and practices, and ESC specifications (measures) from the *Virginia Erosion & Sediment Control Handbook* to those individuals responsible for land-disturbing activities regulated in the Commonwealth,

2. To issue a RLD Certificate of Competence to individuals who demonstrate ESC competence through an on-line or proctor assisted examination, and

3. To improve ESC compliance throughout the Commonwealth to ensure protection to property and natural resources.

This *Applicant Packet* is broken up into the following three Sections: (1) Law and Regulations; (2) Principles and Practices; and (3) ESC Specifications. This *Applicant Packet* highlights key technical, regulatory, and policy features of the ESC Program that are essential for effective and efficient on site ESC plan implementation.

Further information on the RLD Certificate of Competence Program and copies of program publications are available through DCR's website at www.dcr.state.va.us/sw/e&s.htm.

LAW AND REGULATIONS SECTION

LEARNING OBJECTIVES

1. To become familiar with essential terminology in the Virginia Erosion & Sediment Control Law.
2. To understand the land-disturbing activities that are regulated by the Virginia Erosion & Sediment Control Law.
3. To understand the regulatory authority for land-disturbing activities on private, state, and federal lands under the Virginia Erosion & Sediment Control Law
4. To learn the 19 Minimum Standards for erosion and sediment control mandated by the Virginia Erosion & Sediment Control Regulations.

INSTRUCTIONAL ELEMENTS

DEFINITIONS

Below are the definitions of several terms that are essential to understanding the Virginia Erosion & Sediment Control Law (Law) and Erosion and Sediment Control (ESC) Program implementation.

Land-Disturbing Activity means "any land change which may result in soil erosion from water or wind and the movement of sediments into state waters or onto lands in the Commonwealth, including, but not limited to, clearing, grading, excavating, and transporting, and filling of land." The Law is intended to regulate land-disturbing activities exceeding 10,000 square feet in area; however, the thirteen activities briefly listed below are specifically exempt from the definition:

1. Minor land-disturbing activities and individual home landscaping, repairs, and maintenance work;
2. Individual service connections;
3. Installation, maintenance, or repair of any underground public utility lines when such activity is confined to an existing hard surfaced road, street, or sidewalk;
4. Septic tank lines or drainage fields unless included in an overall plan for land-disturbing activity relating to construction of the building to be served by the septic tank system;
5. Surface or deep mining;
6. Exploration or drilling for oil and gas including the well site, roads, feeder lines and off-site disposal areas;
7. Tilling, planting, or harvesting of agricultural, horticultural, or forest crops, or livestock feedlot operations; including a specific list of engineering operations;
8. Repair or rebuilding of the tracks, right-of-way, bridges, communication facilities and other related structures, and facilities of a railroad company;
9. Agricultural engineering operations including but not limited to the construction of terraces, terrace outlets, check dams, desilting basins, dikes, ponds not required to comply with the provisions of the Dam Safety Act, ditches, strip cropping, lister furrowing, contour cultivating, contour furrowing, land drainage, and land irrigation;
10. Disturbed land areas of less than 10,000 square feet in size; however, the governing body of the local program authority may reduce this exception to a smaller area of disturbed land or qualify the conditions under which this exception shall apply;
11. Installation of fence, sign, telephone, electric, or other kinds of post or poles;

12. Shore erosion control projects on tidal waters when the projects are approved by local wetlands boards, the Marine Resources Commission or the United States Army Corps of Engineers; and
13. Emergency work to protect life, limb or property, and emergency repairs;

Erosion and Sediment Control Program means the program administered by the Board, DCR, or a locality pursuant to the Law. The ESC Program includes an outline of the various methods employed by a program to regulate land-disturbing activities and thereby minimize erosion and sedimentation in compliance with the Law. This may include such items as local ordinances, administrative policies and guidelines, technical materials, plan review, inspection, and enforcement provisions.

Erosion and Sediment Control Plan means a document containing material for the conservation of soil and water resources of a unit or group of units of land. It may include appropriate maps, an appropriate soil and water plan inventory and management information with interpretations, and a record of decisions contributing to conservation treatment. The plan shall contain all ESC specifications (also referenced herein as "measures") and major conservation decisions to assure that the entire unit or units of land will be so treated to achieve the conservation objectives.

Agreement in lieu of a plan means a contract between the plan-approving authority and the owner which specifies conservation specifications which must be implemented in the construction of a single-family residence; this contract may be executed by the plan-approving authority in lieu of a formal site plan.

Owner means the owner or owners of the premises on which a regulated land-disturbing activity is undertaken. The owner is responsible for the preparation, submission, approval, and implementation of the ESC plan. The owner is further ultimately responsible for resolving any enforcement actions or damages associated with the activity.

Applicant/Permittee means the applicant or permittee who may be the owner or an agent empowered by the owner to seek plan approval or obtain any required permits.

Responsible Land Disturber (RLD) means an individual holding a certificate of competence issued by DCR who will be in charge of and responsible for carrying out the land-disturbing activity in accordance with the approved plan. The RLD may be the owner, applicant, permittee, designer, superintendent, project manager, contractor, or any other project or development team member. The RLD must be designated on the plan or permit as a prerequisite for plan approval by the Plan-Approving Authority.

Program Authority means an ESC Program operated by DCR, a district, or a locality that has been approved by the Virginia Soil and Water Conservation Board (Board). The Program Authority is responsible for overall administration of an ESC program, including provision of periodic site inspections and issuance of enforcement action to ensure proper plan implementation. The Plan-Approving Authority may assist the local program with project inspection.

Plan-Approving Authority means the Board, Soil and Water Conservation District, Program Authority, or a department of a Program Authority, responsible for review and approval of plans and issuance of required permits. The Plan-Approving Authority must ensure that an RLD has been properly designated prior to plan approval.

DISCUSSION OF REGUALTED LAND-DISTURBING ACTIVITIES

Below is clarification of the exempt status of certain types of land-disturbing activities that have raised question in the past:

1. Activities Disturbing Less Than 10,000 square feet: Activities that disturb less than 10,000 square feet are exempt; however, this limit may be reduced by a locality. This threshold may not be increased. Resource areas designated under the Chesapeake Bay Preservation Act must regulate activities that exceed 2,500 square feet.

2. Home Landscaping and Maintenance Work: This exemption refers only to "minor" land-disturbing activities associated with home ownership. However, it does not apply to clearing operations in excess of 10,000 square feet (or 2,500 square feet in Bay Act areas).

3. Agricultural Activities: The only agricultural activities that are exempt involve the tilling, planting, or harvesting of agricultural, horiticultural, or forest crops, or feedlot operations, including a list of specific engineering operations that support these specific activities. Note that this exemption will not apply to harvesting or forest crops unless the area on which harvesting occurs is reforested artificially or naturally or is converted to bona fide agricultural or improved pasture use in accordance with the Forestry Code (Title 10, Chapter 11, Section 1100 et. Seq.). The construction of farmhouses, barns, livestock/poultry houses, stables, silos, and green houses are not exempt. The construction of roads is exempt if the roads are deemed necessary for tilling, planting, or harvesting operations.

4. Single Family Homes: The construction of homes on subdivision lots is not exempt even if the land disturbance on the single lot is less than 10,000 square feet. The disturbance associated with the entire subdivision is considered in total. The Law states that localities may use an agreement in lieu of a plan in place of a formal erosion and sediment control plan for these lots. Agreements should not be used automatically for all single family construction. Site-specific conditions, such as critical slopes, highly erodible soils, and other parameters, may necessitate a full erosion and sediment control plan.

5. Utilities: Utility activities that are exempt include: (1) individual service connections; (2) installation, maintenance, or repair of underground public utility lines when such activity occurs on an existing hard surfaced road, street or sidewalk if the activity is confined to the area of the road, street, or sidewalk; and (3) installation of telephone or electric post or poles. Construction, installation, and maintenance activities undertaken by private and public electric, communication, and natural gas entities are required to file general erosion and sediment control specifications annually with DCR for review and approval on behalf of the Virginia Soil and Water Conservation Board. Section 10.1-563D of the Law discusses this specifications requirement. Municipal water and sewer construction projects must seek approval of an erosion and sediment control plan from the local erosion and sediment control program.

6. Railroads: Repair or rebuilding of the tracks, right-of-way, bridges, communication facilities, and other related structures, and facilities of a railroad are exempt from the Law. However, new construction of these same items must comply with the provisions of the Law by filing general erosion and sediment control specifications annually with the DCR for review and

approval on behalf of the Virginia Soil and Water Conservation Board. Section 10.1-563D of the Law discusses this requirement.

7. Mining and Drilling: The Law does not regulate surface or deep mining of coal or other mineral resources or exploration or drilling for gas or oil including the well site, roads, feeder lines, and off site disposal areas. These activities are subject to rules established under the Department of Mines, Mineral, and Energy (DMME) and applicable federal regulations.

8. Shore Erosion Control Projects: Shoreline erosion control projects in tidal waters are exempt provided they are approved by local wetlands boards, the Virginia Marine Resources Commissions (VMRC), the Virginia Department of Environmental Quality (DEQ), or the U.S. Army Corp of Engineers. These projects must comply with any permit requirements for conserving natural resources issued by these regulating agencies. VMRC coordinates the Joint Permit Application process for projects operating in state waters and wetlands.

PROGRAM AUTHORITY FOR PRIVATE AND PUBLIC PROJECTS

The Law indicates that the Program Authority for a specific land-disturbing activity is dictated by who owns the land on which an activity will be undertaken. The discussion below outlines the four basic types of projects and the government entity who serves as the regulatory authority.

1. Private: Land-disturbing activities on **private lands** must be covered by an ESC plan approved by the locally operated ESC Program in the jurisdiction in which activity is undertaken. As previously mentioned, municipal water and sewer construction projects are regulated at the local level. The local ESC Program is responsible for program administration, plan review and approval, site inspection, complaint response, and enforcement on these projects.

2. Multi-jurisdictional: Land-disturbing activities that cross local jurisdictions may be regulated at either the local or state level. The applicant has the option of submitting the ESC plan to each locality involved, or to DCR. Inspection and enforcement is generally carried out at the local level.

3. State: Construction projects on **state agency land** must be covered by an ESC plan or annual specifications approved by DCR. Plans must be consistent with local requirements that are more stringent than the state program. DCR is responsible for plan review and approval, site inspection, complaint response, and enforcement on these projects.

4. Federal: Construction projects on **federal lands** must comply with the Law and applicable federal nonpoint source pollution programs on all regulated land disturbing activities in the Commonwealth. The Law gives the Virginia Soil and Conservation Board and local ESC programs the authority to cooperate and enter into agreements with federal agencies to facilitate ESC compliance. As with state projects, plans must be consistent with local requirements that may be more stringent than the state program. The federal agency is responsible for achieving compliance through separate agreements/contracts with on site developers, regular field inspection, prompt enforcement action against non-compliant projects, and/or other mechanisms consistent with agency policy.

MINIMUM STANDARDS

All regulated land-disturbing activities must comply with the 19 Minimum Standards (MS) specified in Section 4VAC50-30-40 of the Virginia Erosion and Sediment Control Regulations (Regulations) that are applicable to the specific project. All ESC Programs are required to confirm that projects are compliant with the criteria, techniques, and policies outlined in the Minimum Standards. An ESC program may waive or modify any of the Minimum Standards that are deemed inappropriate or too restrictive for site conditions by granting a written variance. The 19 Minimum Standards are listed below:

MS-1 Permanent or temporary soil stabilization shall be applied to denuded areas within seven days after final grade is reached on any portion of the site. Temporary soil stabilization shall be applied within 7 days to denuded areas that may not be at final grade but will remain dormant for longer than 30 days. Permanent stabilization shall be applied to areas that are to be left dormant for more than one year.

MS-2 During construction of the project, soil stockpiles and borrow areas shall be stabilized or protected with sediment trapping measures. The applicant is responsible for the temporary protection and permanent stabilization of all soil stockpiles on site as well as borrow areas and soil intentionally transported from the project site.

MS-3 A permanent vegetative cover shall be established on denuded areas not otherwise permanently stabilized. Permanent vegetation shall not be considered established until a ground cover is achieved that is uniform, mature enough to survive, and will inhibit erosion.

MS-4 Sediment basins and traps, perimeter dikes, sediment barriers and other measures intended to trap sediment shall be constructed as a first step in land-disturbing activity and shall be made functional before upslope land disturbance takes place.

MS-5 Stabilization measures shall be applied to earthen structures such as dams, dikes, and diversions immediately after installation.

MS-6 Sediment traps and sediment basins shall be designed and constructed based upon the total drainage area to be served by the trap or basin.

a. The minimum storage capacity of a sediment trap shall be 134 cubic yards per acre of drainage area, and the trap shall only control drainage areas less than three acres.
b. Surface runoff from drainage areas greater than or equal to three acres shall be controlled by sediment basins. The minimum storage capacity for a sediment basin shall be 134 cubic yards per acre of drainage area. The outfall system shall, at a minimum, maintain the structural integrity of the basin during a twenty-five year storm of 24-hour duration. Runoff coefficients used in runoff calculations shall apply to a bare earth condition or those conditions expected to exist while the sediment basin is utilized.

MS-7 Cut and fill slopes shall be designed and constructed in a manner that will minimize erosion. Slopes that are found to be eroding excessively within one year of permanent stabilization shall be provided with additional slope stabilizing measures until the problem is corrected.

MS-8 Concentrated runoff shall not flow down cut or fill slopes unless contained within an adequate temporary or permanent channel, flume, or slope drain structure.

MS-9 Whenever water seeps from a slope face, adequate drainage or other protection shall be provided.

MS-10 All storm sewer inlets that are made operable during construction shall be protected so that sediment-laden water cannot enter the conveyance system without first being filtered or otherwise treated to remove sediment.

MS-11 Before newly constructed stormwater conveyance channels or pipes are made operational, adequate outlet protection and any required temporary or permanent channel lining shall be installed in both the conveyance channel and receiving channel.

MS-12 When work in a live watercourse is performed, precautions shall be taken to minimize encroachment, control sediment transport, and stabilize the work area to the greatest possible extent during construction. Non-erodible material shall be used for the construction of causeways and cofferdams. Earthen fill may be used for these structures if armored by non-erodible cover materials.

MS-13 When a live watercourse must be crossed by construction vehicles more than twice in any six-month period, a temporary vehicular stream crossing constructed of non-erodible material shall be provided.

MS-14 All applicable federal, state, and local regulations pertaining to working in or crossing live watercourses shall be met.

MS-15 The bed and banks of a watercourse shall be stabilized immediately after work in the watercourse is completed.

MS-16 Underground utility lines shall be installed in accordance with the following standards in addition to other applicable criteria:

a. No more than 500 linear feet of trench may be opened at one time.
b. Excavated material shall be placed on the uphill side of trenches.
c. Effluent from dewatering operations shall be filtered or passed through an approved sediment trapping device, or both, and discharged in a manner that does not adversely affect flowing streams or off-site property.
d. Material used for backfilling trenches shall be properly compacted in order to minimize erosion and promote stabilization.
e. Re-stabilization shall be accomplished in accordance with these regulations.
f. Applicable safety regulations shall be complied with.

MS-17 Where construction vehicle access routes intersect paved or public roads, provisions shall be made to minimize the transport of sediment by vehicular tracking onto the paved surface. Where sediment is transported onto a paved or public road surface, the road surface shall be cleaned thoroughly at the end of each day. Street washing shall be allowed only after sediment is removed in this manner. This provision shall apply to individual development lots as well as to larger land-disturbing activities.

MS-18 All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization or after the temporary measures are no longer needed, unless otherwise authorized by the local program. Trapped sediment and disturbed soil areas resulting from the disposition of temporary measures shall be permanently stabilized to prevent further erosion and sedimentation.

MS-19 Properties and waterways downstream from development sites shall be protected from sediment deposition, erosion, and damage due to increases in volume, velocity, and peak flow rate of stormwater runoff for the stated frequency storm of 24-hour duration in accordance with the following standards and criteria:

a. Concentrated stormwater runoff leaving a development site shall be discharged directly into an adequate natural or man-made receiving channel, pipe, or storm sewer system. For those sites where runoff is discharged into a pipe or pipe system, downstream stability analyses at the outfall of the pipe or pipe system shall be performed.
b. Adequacy of all channels and pipes shall be verified in the following manner:
    i. The applicant shall demonstrate that the total drainage area to the point of analysis within the channel is one hundred times greater than the contributing drainage area of the project in question; or
    ii. (a) Natural channels shall be analyzed by the use of a two-year storm to verify that stormwater will not overtop channel banks nor cause erosion of channel bed or banks; and
    (b) All previously constructed man-made channels shall be analyzed by the use of a ten-year storm to verify that stormwater will not overtop its banks and by the use of a two-year storm to demonstrate that stormwater will not cause erosion of channel bed or banks; and
    (c) Pipes and storm sewer systems shall be analyzed by the use of a ten-year storm to verify that stormwater will be contained within the pipe or system.
c. If existing natural receiving channels or previously constructed man-made channels or pipes are not adequate, the applicant shall:
    i. Improve the channel to a condition where a ten-year storm will not overtop the banks and a two-year storm will not cause erosion to the channel bed or banks; or
    ii. Improve the pipe or pipe system to a condition where the ten-year storm is contained within the appurtenances; or
    iii. Develop a site design that will not cause the pre-development peak runoff rate from a two-year storm to increase when runoff outfalls into a natural channel, or will not cause the pre-development peak runoff rate from a ten-year storm to increase when runoff outfalls into a man-made channel; or
    iv. Provide a combination of channel improvement, stormwater detention, or other measures to prevent downstream erosion satisfactory to the plan-approving authority.
d. The applicant shall provide evidence of permission to make the improvements.

e. All hydrologic analyses shall be based on the existing watershed characteristics and the ultimate development of the subject project.
f. If the applicant chooses an option that includes stormwater detention, he shall obtain approval from the locality of a plan for maintenance of the detention facilities. The plan shall set forth maintenance requirements of the facility and designate the person responsible for performing the maintenance.
g. Outfall from a detention facility shall be discharged to a receiving channel, and energy dissipaters placed at the outfall of the detention facilities as necessary to provide a stable transition from the facility to the receiving channel.
h. All on-site channels must be verified to be adequate.
i. Increased volumes of sheet flows causing erosion or sedimentation on adjacent property shall be diverted to a stable outlet, adequate channel, pipe or pipe system, or to a detention facility.
j. In applying these stormwater runoff criteria, individual lots or parcels in a residential, commercial, or industrial development shall not be considered to be separate development projects. Instead, the development as a whole shall be treated as a single project. Hydrologic parameters that reflect the ultimate development state shall be used in all engineering calculations.
k. All measures used to protect properties and waterways shall be executed in a manner that minimizes the impact on the physical, chemical, and biological integrity of rivers, streams, and other state waters.

PRINCIPLES AND PRACTICES SECTION

LEARNING OBJECTIVE

1. To understand the basic **principles** of erosion and sedimentation.
2. To understand the seven **practices** that are essential to successful implementation of erosion and sediment controls on construction sites.
3. To understand the inspection responsibilities of the RLD during active construction.

INSTRUCTIONAL ELEMENTS

GUIDING PRINCIPLES

There are three overriding principles of erosion and sediment control (ESC) that provide the basis for all planning and design work. These should form the basis for each development project. The three principles are:

1. Erosion control
2. Sediment Control
3. Coordination

Erosion control is the first line of defense; if there is no erosion, there can be no sediment. Control at the source of material prevents both erosion damages and sediment damages. In some instances, this may be the only way to have an acceptable level of control of the very fine sediments. In many instances, in field situations, it will be impossible or impractical to impound water laden with this fine material for long enough periods for it to settle out.

Sediment control is the second line of defense. It provides a backup when all possible erosion control measures have been utilized. Sediment should be filtered out of the runoff water or allowed to settle out before the runoff leaves the site. Care must be taken so that runoff released from the site will not cause channel erosion and sediment damage downstream.

These lines of defense must be coordinated to achieve the most effective level of protection. This calls for coordination of erosion and sediment control operations and coordination of these with the overall plan for the development. Erosion control will seldom, if ever, be completely effective during construction. Adequate provisions for trapping sediment before it leaves the site must back up erosion control. To prevent downstream damages, an evaluation must be made to determine what is needed to counteract the higher runoff that will occur after development. Facilities should be provided to reduce the damages that might otherwise occur. Erosion and sediment control must be planned along with the total plan for the site. If this is not done during or along with the planning for the total development, the land developer will be left with limited, costly, and unsatisfactory options for erosion and sediment control.

GEOLOGIC vs. ACCELERATED EROSION

Soil erosion is usually defined as the wearing away of the land surface by water, wind, ice, and gravity. In Virginia, we are primarily concerned with erosion by water. For our purposes, we can define soil erosion as a process of detachment and transportation of soil materials by erosive agents.

Erosion is not a recent phenomenon. It has been occurring since the beginning of time. Whole mountains have eroded away. Sediment deposits several miles thick have been formed. Features as spectacular as the Grand Canyon have resulted from erosion. This natural process is called geologic erosion. It seldom is discernible to us. It usually continues as a slow natural process unless it is disturbed by the activities of man. Geologic erosion produces about 30% of the total sediment in the U.S.

The erosion about which we are more concerned results from man's use of the land. This type is called accelerated erosion since the geologic rate is increased by the intervention of man. In this country, accelerated erosion began when the first settlers from Europe cleared sloping land and planted soil-exposing crops. Accelerated erosion accounts for about 70% of all the sediment produced in the U.S.

Surface mining, forestry, agriculture, and construction are the major activities causing accelerated erosion. About 71% of the sediment generated by accelerated erosion comes from agricultural land. Cropland is the chief source of this sediment. Construction activities, surface mining, forestry, and stream channel erosion account for the remaining 29%. Indirect effects of construction may be resulting in much higher sediment production than the direct activities. Stormwater runoff from impervious surfaces in urban areas is causing many streams that were relatively stable to suffer severe channel erosion.

THE FIVE TYPES OF EROSION

Raindrop erosion is the first effect of a rainstorm on the soil. Raindrop impact dislodges soil particles and splashes them into the air. These detached particles are then vulnerable to sheet erosion.

Sheet erosion is the erosion caused by a shallow sheet of water as it runs off the land. These very shallow, moving sheets of water are seldom the detaching agent, but the flow transports soil particles that are detached by raindrop impact and splash. The shallow surface flow rarely moves as a uniform sheet for more than a few feet on land surfaces before concentrating in surface irregularities.

Rill erosion is the erosion that develops as the shallow surface flow begins to concentrate in the low spots of the irregular conformation of the surface. As the flow changes from shallow sheet flow to deeper flow in these low areas, the velocity and turbulence of flow increase. The energy of this concentrated flow is able to both detach and transport soil materials. This action begins to cut tiny channels of its own. Rills are small but well-defined channels that are, at the most, only a few inches deep. They are easily obliterated by harrowing or other surface treatments, and have no more than 1 square foot cross-section.

Gully erosion occurs as the flow in rills comes together in larger and larger channels. The major difference between gully and rill erosion is size. Gullies are too large to be repaired with conventional tillage equipment and usually require heavy equipment and special techniques for stabilization.

Channel erosion occurs as the volume and velocity of flow cause movement of the stream bed and bank materials.

FACTORS INFLUENCING EROSION

There are four major factors which have a direct influence on the detachment and transportation of soil materials. These are:

1. Climate
2. Soils
3. Topography
4. Vegetation (or surface cover)

Climate

We will first discuss climate since it is the source of the major erosive agent in the erosion process. When we talk about climate we are primarily concerned with rainfall, although temperature and snow cover are also important. The discussion of rainfall can be divided into the effects of raindrops and the effects of runoff.

Raindrop erosion is the first step in the erosion process. The action of falling rain is responsible for 90% or more of total soil erosion. It produces two damaging effects: the detachment and transportation of surface soil and the puddling or sealing of the soil surface. Neutralizing these two effects is the first and most important part of erosion control.

How can rainfall be responsible for so much damage? Observations of a hard rain on bare soil confirm its destructive power. The drops hit the surface like tiny bombs. They shatter soil granules and splash the detached material back and forth. Splashed particles may be moved more than two feet high and five feet horizontally. On level land, this is self-canceling. On sloping land, the net movement is downhill. On a 10% slope, 75% of the soil movement is downslope. More than 100 tons of soil per acre may be detached in a single rain.

The erosive capacity of rainfall comes from the energy of its motion, or kinetic energy. It is dependent upon the amount and intensity of rainfall, raindrop diameter, and raindrop velocity.

Drop size varies from the finest mist to drops which are 1/3 inch in diameter. Any rain will contain drops of various sizes. A hard rain has a much higher proportion of large drops.

Raindrop velocity is tied very closely to drop size. Fine mists with droplets of about 1/100 inch diameter fall at a rate of about 1 inch per second. The largest drops attain a velocity of 30 feet per second. It is obvious from this that rain falling as large drops in a hard thunderstorm has many times more erosive capacity than that falling as fine drizzle over a longer period of time. The actual force of raindrop impact in a hard summer storm may be 2 or 3 hundred times the force of the surface runoff, even on steep slopes.

The effects of splash erosion are easy to see in nature. Splashed soil particles can be seen clinging to the foundation of buildings that are adjacent to bare soil. Particles can be seen on stems and leaves of plants that are growing in a partially vegetated field. Pedestals of soil, capped with protective stones, can be seen where raindrop splash carried away unprotected material.

Another important aspect of rainfall is its distribution. The most erosive rains are not scattered evenly throughout the year. In Virginia, they are concentrated in the months of June through September.

Unfortunately, this period of most erosive rain coincides with the most active part of the construction season.

Table 1 indicates some significant differences between storms occurring during the spring and summer and those occurring in the fall and winter.

TABLE 1
PRECIPITATION CHARACTERISTICS BY SEASON

CHARACTERISTICS	SEPT – APRIL	MAY – AUGUST
Form	Rain and Snow	Rain
Intensity	Low	High
Drop Size	Small	Large
Duration of Storm	Long	Short
Area of Storm	Large	Small

So far we have concentrated on the force of falling rain and its capacity to detach and move soil material. Another damaging effect of raindrops is the compacting, puddling, and sealing of the soil surface. As mentioned before, large drops strike with tremendous impact, compacting the soil under the point of impact. Repeated strikes churn the surface into a slurry. As this semi-fluid mass attempts to infiltrate the soil, it does a very effective job of sealing the pore spaces against further entry of water. As drops continue to beat against the surface, they sort and compact the material until an almost complete seal is formed. Even on coarse sands, this action reduces the intake of water.

This brings us to the other damaging aspect of rainfall-runoff. Runoff begins when the rate of rainfall exceeds the intake capacity of the soil. When a hard rainfall is unimpeded as it strikes the soil, runoff begins a few minutes after the start of the rain. In the early stages, its major potential for damage is as a transporting agent for soil dislodged by raindrop splash. As water begins to collect on the surface, it has no kinetic energy. It derives energy from its movement as it begins to run downslope. The amount of runoff depends on two things: the amount and intensity of the rainfall, and the nature of the soil or intervening surface that it falls upon. Runoff at first takes the form of a layer of water flowing more or less uniformly over the ground. Depth of this flow is usually very shallow. Flows of this sort have practically no capacity to detach soil, but they do have the capacity to transport particles that are detached and kept in suspension by raindrop impact. The result of this combination of the detaching capacity of raindrops and the transporting capacity of sheet-flow runoff is sheet erosion. The effects of this type of erosion occur on all parts of the land surface except in rills and gullies. Because it removes soil in thin layers from 95% or more of the land surface, it is difficult to observe, even though the total soil loss may be tremendous.

Under normal field conditions, runoff occurs both as sheet flow and channel flow. As water moves downslope, it tends to follow the path of least resistance. The flow begins to concentrate in the depressions and irregularities of the land surface. This is the beginning of channel flow. As the amount of water in these channels increases, the velocity and turbulence also increases. As the runoff concentrates first in tiny channels then combining into larger and larger ones, it gains the force to both detach and transport soil material. The erosive capacity of flowing water is based upon its velocity, turbulence, the amount and type of abrasive material flow, the roughness of the channel, and the slope gradient. As the length of slope increases, the depth, and hence the velocity, also increases.

Detachment by flowing water is confined primarily to the areas of concentrated flow (rills and gullies). Rolling, lifting, and abrasive actions influence the detachment of soil particles. The force is horizontal, in the direction of the flow. The flow force detaches particles by rolling or dragging them out of position. As velocity and turbulence increase, vertical currents and eddies occur. This upward movement of water lifts soil particles from their place and sets them in motion. As the particles of soil already transported by the flow strike or drag over other soil particles, they detach them and set them in motion. This is detachment by abrasive action. The amount and abrasiveness of the flow particles influences the amount of soil detached by abrasion.

The same factors that determine detaching capacity act to determine the transporting capacity. As mentioned before, sheet flow has very little detaching capacity. It is effective in transporting soil materials because raindrop impact keeps the material in suspension. It has been observed that muddy water flowing across a parking lot leaves a deposit of mud under each car while the adjacent pavement is washed clean. In this case, the velocity and turbulence of flow alone is not enough to keep the material in suspension. The material detached by raindrops and transported by sheet flow is the more finely textured soil material.

The flow in rills and gullies transports material by "surface creep," "saltation," and suspension. In surface creep, the particles roll or slide along the bottom of the rill or gully. The particles move by saltation when the uneven forces of turbulence lift and move them by jumps. Particles travel in suspension when the upward velocities of turbulent flow exceed the gravitational weight of the soil material. In general, larger particles are moved by surface creep and saltation while smaller particles are moved by suspension. Unless limited by the amount that can be detached, the total amount of material moved depends on the transportation capacity of the runoff and the transportability of the soil material.

Soil

The second major factor influencing erosion is the soil. When all other factors are held constant, different kinds of soil erode at different rates. Soil differences may cause more than a tenfold difference in erosion rates. The difference in erosion rates that is due to the properties of the soil itself is called soil erodibility.

The soil properties that influence erodibility by water are: (1) those properties that affect the rate at which water enters the soil (infiltration rate), (2) properties that affect the rate at which water moves through the soil (permeability), (3) the total water volume, (4) factors affecting detachment by raindrop impact and detachment by rolling, lifting, and abrasion of flowing water, and (5) characteristics of the soil that allow it to resist the transporting forces of rainfall and runoff.

Soil erodibility has been investigated intensively in development of the Universal Soil Loss Equation. The important properties are: (1) particle size and gradation, (2) percent of organic matter, (3) soil structure, and (4) soil permeability. There are several additional properties that influence soil erodibility, but the above account for approximately 85% of the variance in observed soil loss.

There is a very good correlation between erodibility and an index derived from five soil parameters. Two of these reflect particle size and gradation while the other three are percent organic matter, soil structure, and soil permeability.

Soil particle size distribution plays a major role in determining erodibility. Erodibility tends to increase with increased silt and very fine sand content; and to decrease with increased sand, clay, and organic matter content. Soils with a high clay content are generally more resistant to detachment,

although once detached, the clay particles are easily transported. Clay also usually has poor infiltration, thus increasing runoff. An increase in organic matter reduces erodibility by improving structure and the stability of structure. Organic matter also improves permeability.

To the RLD and inspector, who are likely to be laymen in the field of soils, a good indicator of how badly a soil can be expected to erode is its erodibility factor (K). These soil erodibility factors were developed for an equation, the Universal Soil Loss Equation, that predicts soil loss. If the name of a particular soil is known, its erodibility factor can be researched in Appendix 6C of the 1992 *Virginia Erosion and Sediment Control Handbook*. The greater the K factor, the greater the soil's erodibility. K factors are grouped into three ranges:

1. 0.23 and lower – low erodibility
2. 0.24 – 0.36 – moderate erodibility
3. 0.37 and higher – higher erodibility

It is a good idea to inventory the soils on a site before beginning construction to identify the areas with highly erodible areas. Assistance in soil identification is available from the local USDA Natural Resource Conservation Service office.

Topography

In the two topics discussed thus far, we have covered the causes of water erosion. We have been concerned with the power of rain to erode soil and the resistance or susceptibility of soil to water erosion. The remaining two topics, "Topography" and "Surface Cover," discuss factors that may modify water erosion.

In terms of erosion, slope characteristics are the most important part of site topography. These characteristics include steepness, length, contour, and slope direction. Slope length is the distance from the point where overland flow begins to the point where it becomes a well-defined waterway (or soil deposition location) resulting from a reduction in slope grade. The longer the slope, the greater the runoff depth. As water descends a slope, its velocity and channel depth increases. As a general rule, erosion risk becomes critical when slope length exceeds the following values:

Slope Gradient	Slope Length
0-7%	300 feet
7-15%	150 feet
15% and over	75 feet

Slope steepness influences erosion in several ways. Steep slopes tend to increase the incidence of downhill splash. Moreover, flow velocity and runoff increase proportionate to slope steepness. Slope gradients are grouped into three risk categories:

0-7%	Low Erosion Risk
7-15%	Moderate Erosion Risk
15% & over	High Erosion Risk

The shape of slopes can affect erosion. On convex slopes (slopes which steepen at the lower end) the erosion potential is greater. On concave slopes (slopes that flatten at the lower end) the erosion potential will be less.

Direction of slope has an indirect effect simple because of the effect that exposure has on vegetation. South and southwest facing slopes are usually the hardest to vegetate and maintain when all other slope factors are considered to be equal.

Surface Cover

Surface cover is the last of the four factors influencing erosion. IT IS PERHAPS THE MOST IMPORTANT FACTOR FROM THE STANDPOINT OF CONTROL. Research has shown that the amount of erosion is proportionate to the amount of bare soil that is exposed to raindrop impact. The use of vegetation, mulches, and other surface covers offers the greatest range of control alternatives.

One further value of vegetation is its effect on runoff velocity. Certain types of vegetation are known to be very effective in reducing erosion caused by flowing water. Vegetation is frequently used to provide a protective lining in shallow waterways.

IMPLEMENTATION OF EROSION AND SEDIMENT CONTROLS

The following section breaks down the implementation of an erosion and sediment control plan into seven practices, primarily from the perspective of the Responsible Land Disturber (RLD). The seven practices are:

1. Site Review
2. Pre-Construction Conference
3. Site Preparation
4. Inspection and Maintenance
5. Grading and Utilities Installation
6. Building Construction
7. Permanent Site Stabilization

Site Review

The RLD must be thoroughly familiar with both the existing conditions at the construction site and the approved ESC plan for the land-disturbing activity.

The RLD should note all existing critical areas indicated on the plan and then actually identify their location and extent on the ground. These should include stream channels and associated flood plain areas, drainage ways and outlets into streams, points where land-disturbing activities are adjacent to or must cross steams and drainage ways, steep slopes and highly erodible soils, and runoff entering the site from adjacent areas. The RLD should note what practices are specified to protect these areas. Also, he or she should be aware of critical areas not specifically treated in the plan. These issues should be discussed at the pre-construction conference with the contractors, consultants, and other appropriate parties who will be operating on site.

Next, the RLD should determine the location of all control measures and determine their appropriateness for existing site conditions and the planned project. The RLD should document any needed plan modifications and discuss these at the pre-construction conference.

Further, the RLD should check the schedule for the installation of erosion and sediment control (ESC) and their relationship with land-disturbing activities. The site must be protected as a first step before land-disturbing activities are started. Major land-disturbing activities should be phased in order to limit the size of denuded areas exposed at any time. The timing, sequence, and staging of control installations are important elements of the plan that should be assessed prior to the project initiation.

Pre-Construction Conference

Following review of the site, the RLD should set up a pre-construction conference and site review with on site contractors, consultants, and the inspector from the program authority. Attendance by the local inspector assigned to the site is essential to establish lines of communication early in the plan implementation process. Further, the site review will help all parties to fully understand their responsibilities prior to, during, and following active construction. All aspects of the plan and any suggested modifications and questions should be discussed to ensure that the RLD and all parties are in agreement regarding the plan and scheduling. Special attention should be given to perimeter practices designed to prevent damage to critical areas, adjacent properties, and/or natural resources.

The **location** of all measures should be carefully considered. If study of the plan indicates that adjustments in location are needed, these should be discussed with the RLD. The RLD may authorize minor adjustments, such as moving a diversion from a property line to a grading limit, or shifting an outlet to match a natural depression in the land. However, major adjustments may require formal revision of the plan and should be approved by the plan-approving authority.

The **sequence** and **phasing** of the installation of practices and land-disturbing activities should also be discussed. The guidelines for ESC planning require that sediment basins and other appropriate measures be installed prior to, or as a first phase of, land grading. Other appropriate measures include construction entrances, diversion dikes, interceptor dikes, perimeter dikes, gravel outlet structures, level spreaders, waterways or outlets, and grade stabilizing structures. The RLD must emphasize the importance of establishing these practices before grading begins.

The Minimum Standards should be checked to be sure that all applicable standards will be satisfied. A Minimum Standards Checklist may be used to quickly accomplish this task. Approved variances and associated formal documentation should be noted, and it should be determined if any additional measures or variances are needed.

Site Preparation

One of the first steps in preparing a site for active construction is to lay out all traffic circulation routes and storage areas. Route locations should be chosen so they pose the least threat to identified critical areas. Existing well-vegetated areas should be damaged as little as possible and soil stockpiles should be located a safe distance from waterways and streams. Barriers may be required to keep traffic within the delineated areas, or at least out of the critical areas. If needed, they should be installed before opening the site to general construction traffic.

Required structural sediment trapping practices should be installed and stabilized as a first step measure before general grading begins. (Note that compacting, seeding, and mulching are required to stabilize these practices.) Next, waterways and outlets should be installed with the vegetation or lining material called for in the plan.

The entire site work force should be instructed about the location of critical areas and associated ESC practices and the need to protect these areas from damage.

Inspection and Maintenance of ESC Specifications

Maintenance must begin as soon as the first temporary ESC specification is installed and must continue through all the succeeding activities until the permanent specifications or structures are established and functioning. The features of a maintenance program are described in the narrative part of the plan. All structural specifications should be checked at the close of each workday and before and after each rainstorm. Diversion berms should be checked to see that they have not been breached by equipment. The condition of level spreader areas, waterways, and other outlets should also be checked. Traffic should be moving within the established access routes. Perimeter controls and conveyance channels should be checked for sediment deposits or other impeding material. Repairs should always be made promptly when damages are discovered. When repairing waterways or other channels, the new lining material should be non-erosive. Vegetative practices and cover on structural practices require maintenance fertilizer and, perhaps, mowing on a regular basis.

All sediment traps and basins should be checked after each storm and cleaned out when the deposited material reaches the level designated in the plan.

Grading and Utility Construction

The fifth major step is site grading and utility installation. If stockpiling of fill or topsoil is planned, a pre-selected, relatively isolated stockpile area should be used. To minimize erosion, the slopes of the stockpile should be flattened at the end of each working period. The stockpile should be mulched and seeded if it's to remain dormant or is no longer needed.

Disturbed areas that can be brought to final grade at this stage during an appropriate season for seeding should be seeded, sodded, or otherwise stabilized with the permanent material and techniques indicated in the plan. If they cannot be seeded, they should be stabilized with anchored mulch or other appropriate stabilization measures. Areas to remain at rough grade for more than 30-days before permanent stabilization should be mulched and seeded to provide temporary cover within 7 days.

Utilities such as storm sewers, sanitary sewers, electric and communication lines, water mains, and gas mains are usually installed at this time. To minimize the amount of area disturbed, the work should be organized and the trenches sized to accommodate several utilities in one trench. The installation should be carefully coordinated to reduce the time that the trenches will stay open. Note that no more than 500 linear feet of trench may remain open at one time. If sediment-laden water must be pumped from utility trenches, it should be conveyed safely to an appropriate filtering measure (dewatering devices, sediment trap or basin). As soon as possible, trenches should be filled, compacted, mulched, and seeded to provide temporary or permanent stabilization. Further, as soon as the storm sewers are installed, inlet protection should be installed to prevent sediment from entering the system. If required, storm drain outlet protection should also be installed.

Building Construction

The sixth major step or stage is building construction. Two major hazards are common during this step. The introduction of additional equipment and work force brings added risks to areas requiring protection. Efforts to control traffic must be increased during this period. All traffic should be confined to established travel routes. The second hazard is from excavated material. This phase usually results in high volumes of soil for disposal and stockpiling. Stockpiles should be located where they will not wash into drainage ways or onto previously stabilized areas. The slopes on these areas should be flattened and

protected by anchored mulch and temporary seeding. Excavations should be backfilled as soon as possible, and appropriate surface protection and stabilization should be provided.

Permanent Site Stabilization

The last step is permanent stabilization. As mentioned earlier, this should not be delayed until the entire development is completed. A significant reduction in erosion damage repair and re-grading costs can be achieved if smaller areas are stabilized with permanent vegetation as soon as they are ready.

Most temporary sediment basins, dikes, sediment traps, and other earthen control structures are to be removed, re-graded, mulched, and seeded before leaving the site. However, the RLD should consult the plan before removing them to ensure that they are not removed until the surrounding area is stabilized and they are no longer needed.

In some cases, sediment basins, diversions, and waterways are to remain as part of the permanent stormwater runoff management system. In such cases, sediment basins should be cleaned out and seeded with suitable permanent vegetation. Diversions and waterways should be checked, repaired if needed, and left in good condition. The RLD should check on the final condition of permanent measures and confirm that long-term maintenance of these facilities is accounted for.

When final grading is completed, all denuded areas should be stabilized with permanent vegetation. The ESC specifications for permanent vegetative practices are provided in the Specifications Section.

PROJECT INSPECTION BY RESPONSIBLE LAND DISTURBER

The RLD should inspect the site frequently throughout the project, with careful inspection at installation of critical measures (e.g., sediment basins) and at the end of each phase for phased projects. The RLD will need to coordinate to ensure that appropriate parties (job superintendent, foreman, etc.) are available to participate in the inspection. Additionally, communication with the inspector from the Program Authority may also be required to coordinate on site visits. The RLD should be familiar with the plan and construction schedule ahead of time. Any required repairs or corrective actions indicated by the RLD should be made immediately. Any plan modifications recommended by the RLD should be discussed with the Owner and Plan-Approving Authority prior to implementation on site.

The RLD should also use a standard checklist when performing inspections. Most of the items on that checklist refer to a specific Minimum Standard (MS). The items from the checklist are listed below:

- ✓ Are there any denuded areas that require temporary or permanent stabilization? (MS-1)
- ✓ Are soil stockpiles adequately stabilized with seeding and/or sediment trapping measures? (MS-2)
- ✓ Does permanent vegetation provide adequate stabilization? (MS-3)
- ✓ Have sediment-trapping facilities been constructed as a first step? (MS-4)
- ✓ Are perimeter sediment trapping measures in place and earthen structures seeded and mulched? (MS-5)

- ✓ Have sediment basins been installed where needed? (MS-6)
- ✓ Are all cut and fill slopes adequately stabilized? (MS-7)
- ✓ Are all on-site drainage channels and outlets adequately stabilized? (MS-8&9)
- ✓ Are all operational storm sewer inlets protected so that sediment will not enter the system? (MS-10)
- ✓ Have stormwater conveyance channels been adequately stabilized? (linings and/or outlet protection) (MS-11)
- ✓ Is there any work going on in live streams that may require stabilization or a temporary stream crossing? (MS-12, MS-13, MS-14)
- ✓ Are utility trenches backfilled, seeded, and dewatered properly? (MS-16)
- ✓ Is there any evidence of dirt or mud the road? (MS-17)
- ✓ Are there any structural practices that should be removed because they are no longer needed? (MS-18)
- ✓ Do any structural practices require repair or clean-out to maintain adequate function? (MS-18)
- ✓ Are properties and waterways downstream from development adequately protected from erosion and sediment damage due to increases in peak stormwater runoff? (MS-19)

If violations of a plan or potentially hazardous situations are noted, they should be immediately reported to the Owner. The RLD may be able to suggest economical ways to achieve desirable corrections. In any case, it is wise to set a reasonable deadline for accomplishing necessary corrections. Plan changes or cases of non-compliance (such as commencing land disturbance without an approved plan) should be addressed with the Plan-Approving Authority and Program Authority as appropriate.

The common thread in any successful plan implementation is the need to reach timely solutions to issues that arise on site prior to and during plan implementation. By becoming knowledgeable in the Virginia ESC Program, developing a cooperative working relationship with on site parties, and exercising common sense, the RLD can facilitate efficient and economical plan implementation.

EROSION AND SEDUMENT CONTROL SPECIFICATIONS SECTION

LEARNING OBJECTIVE

1. To become familiar with the description, construction details, and maintenance procedures for 25 erosion and sediment control specifications recommended by the Virginia ESC Program.

INSTRUCTIONAL ELEMENTS

This Section contains the description, construction details, and maintenance procedures for 25 of the most commonly applied structural and vegetative ESC specifications included in the *Virginia Erosion & Sediment Control Handbook* (Third Edition, 1992). The index below provides a list of the specifications covered in this Section.

ESC SPECIFICATIONS INDEX